JPL's Interplanetary Network Directorate

Suzy Dodd
Les Deutsch
Sami Asmar

September 2017

Jet Propulsion Laboratory
California Institute of Technology

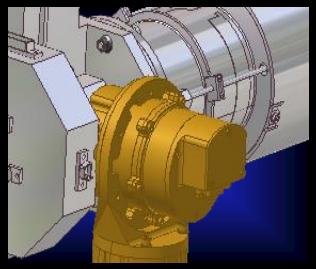
Interplanetary Network Directorate "At a Glance"

JPL Directorate responsible for

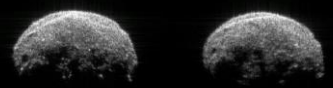
Deep Space Network (DSN)
Unique global facilities that communicate with and track spacecraft beyond Earth orbit

Advanced Multimission Operations System (AMMOS)
Multimission tools and services – core of mission ground (and beyond) data systems including

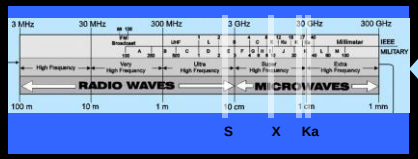
Planetary Data System (JPL nodes)
Unified repository and tools for science data



Communications and navigation technology
End-to-end responsibility



DSN science instrument development
Use of DSN as a science instrument



JPL Spectrum Program
Manage radio emissions at and near JPL facilities

JPL Standards Program
Negotiate international engineering standards for communications, tracking, and mission operations

The Deep Space Network
NASA's Connection to the Moon, Planets, & Beyond

- Captures all information from our spacecraft
  - Most sensitive receivers
- Sends all instructions to them
  - Most powerful transmitters
- Provides most of the navigation
  - Most stable clocks and best algorithms
- Enabling more than 30 spacecraft in flight today

DSN 70m Antenna at Goldstone, California

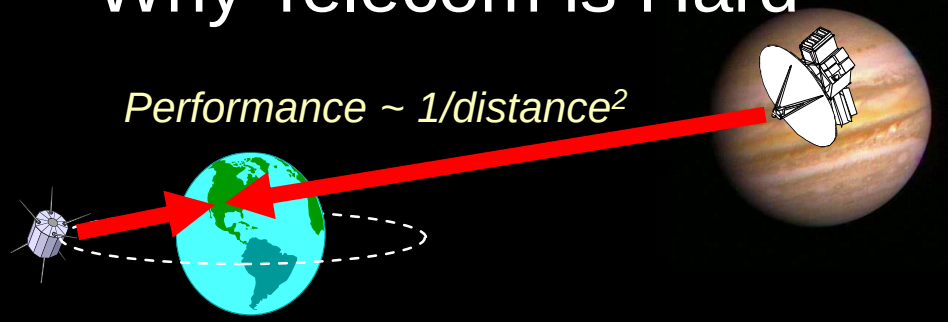
Space Loss

- All else being equal, communications performance is inversely proportional to distance squared

P_R/N_0 = constant / d^2

- Need to overcome this problem of physics to be successful in deep space

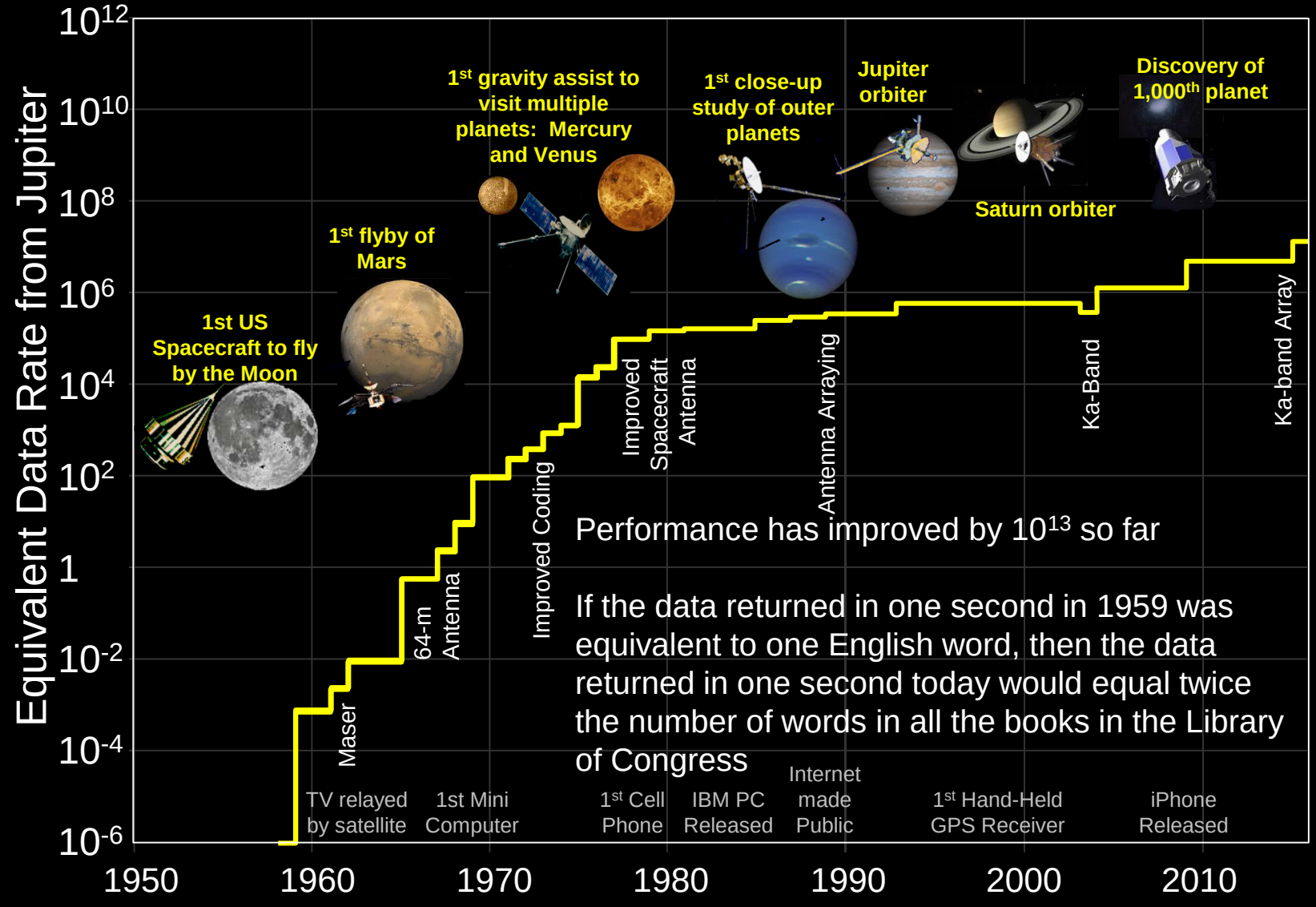
Why Telecom is Hard



Relative Difficulty

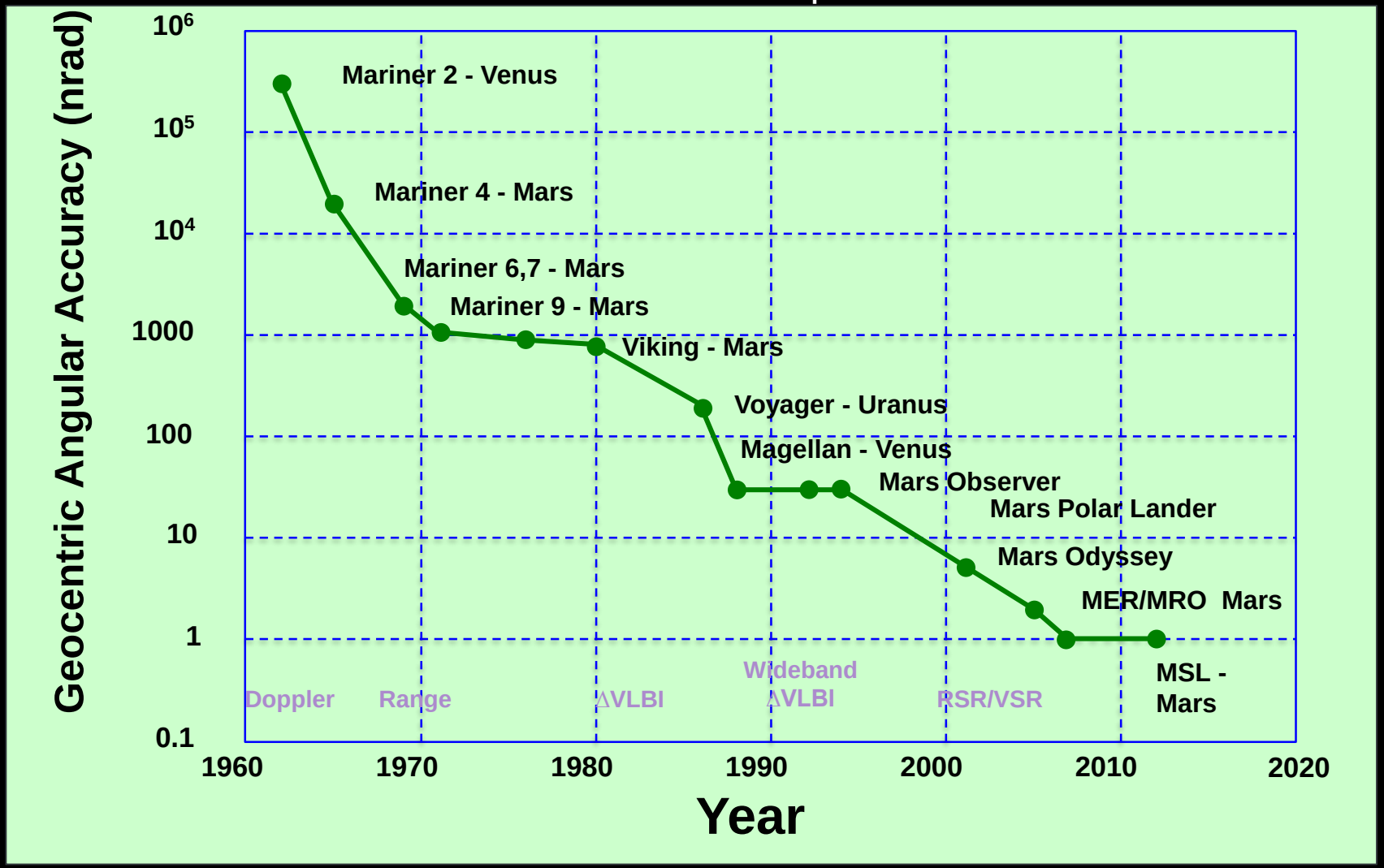
Place	*Distance*	*Difficulty*
Geo	*$4x10^4$ km*	*Baseline*
Moon	*$4x10^5$ km*	*100*
Mars	*$3x10^8$ km*	*$5.6x10^7$*
Jupiter	*$8x10^8$ km*	*$4.0x10^8$*
Pluto	*$5x10^9$ km*	*$1.6x10^{10}$*

Continually Enabling Missions



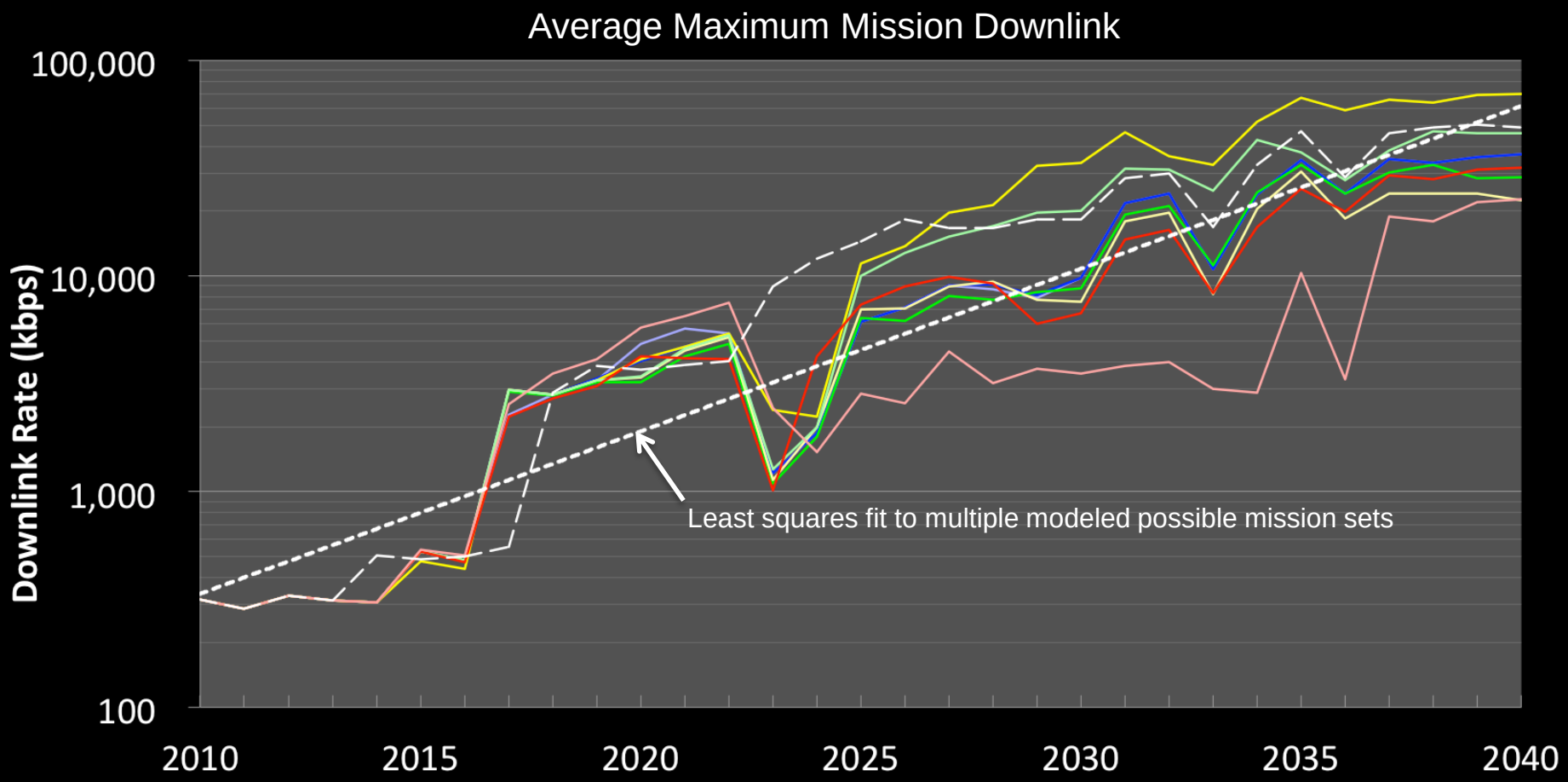
Deep Space Navigation

- Steering a probe to its destination is often a critical problem
- Measurements of the communication links provide much of the data

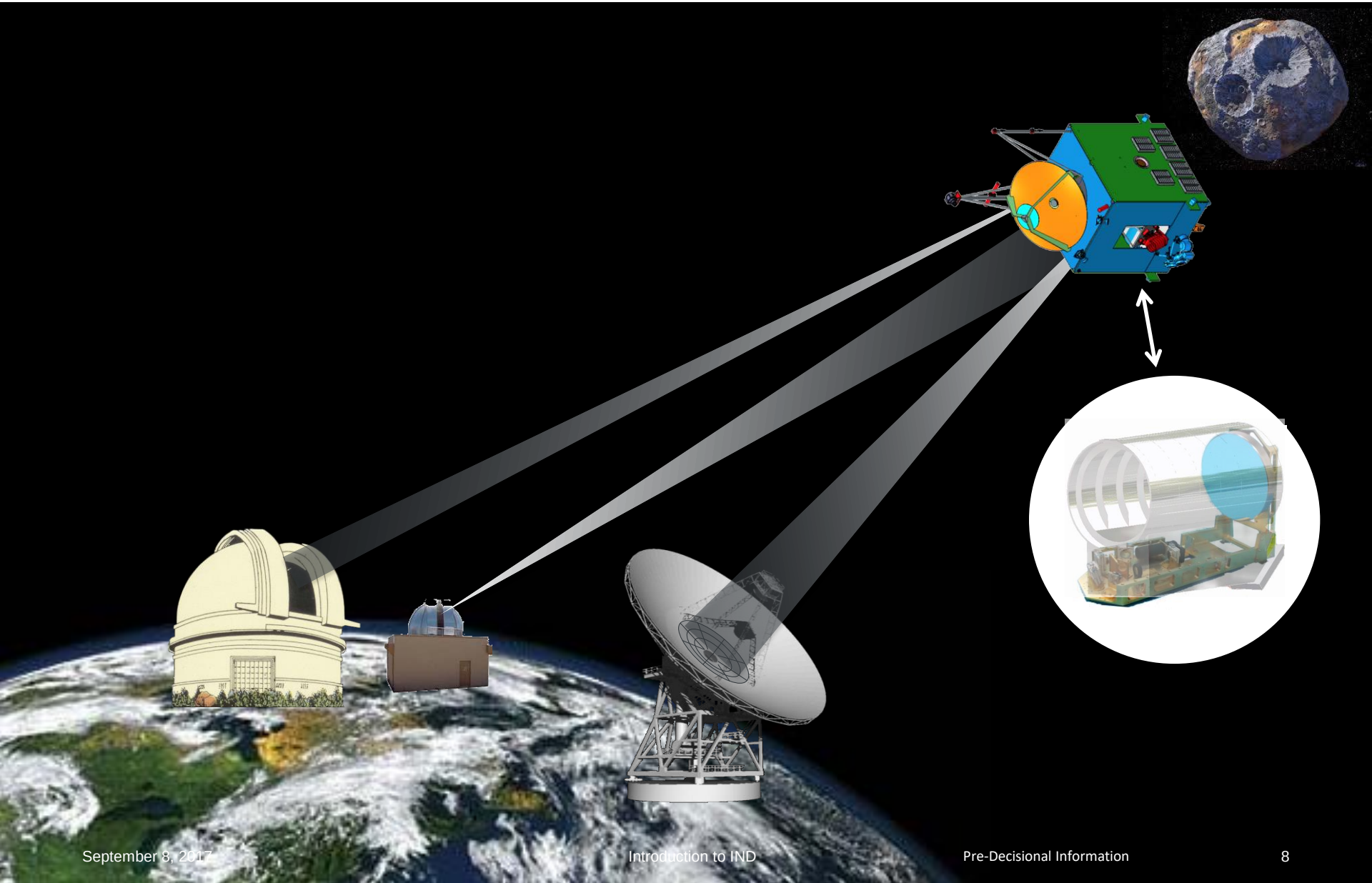


Expected Growth in Data from Deep Space

We must increase DSN capability by close to 10X per decade enable future missions

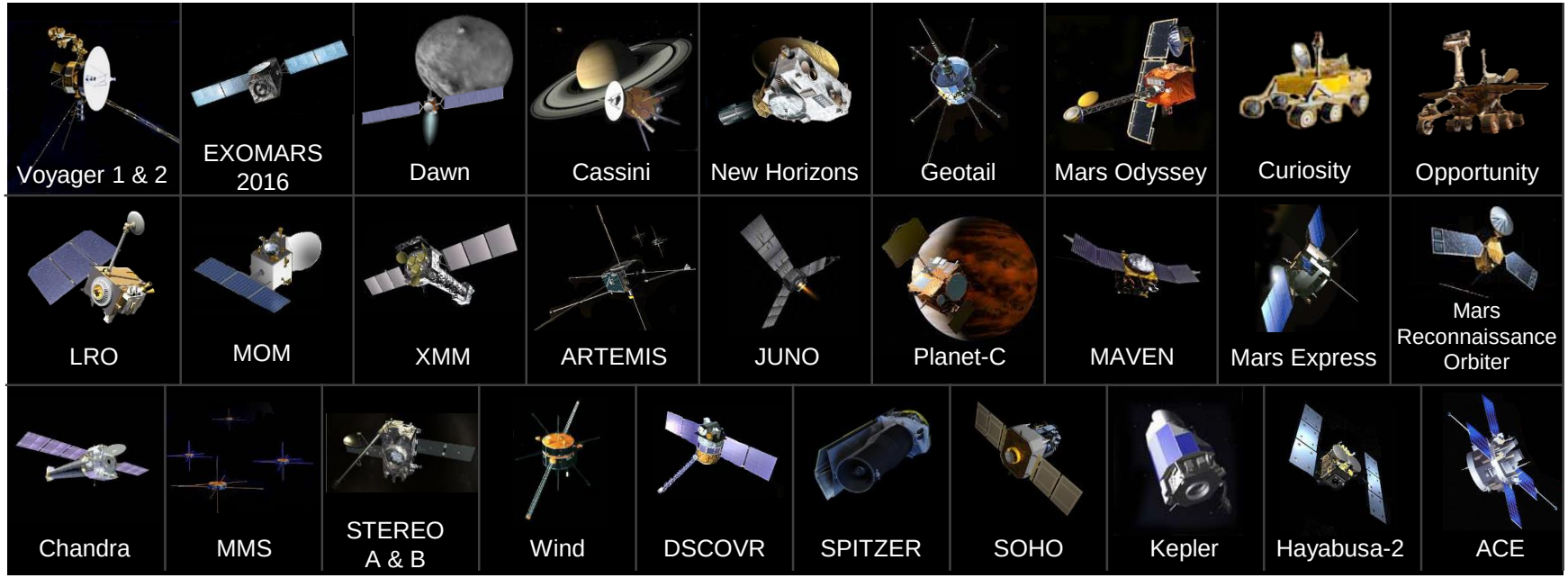


Optical Comm – Planned Psyche Demo



The future is bright – and crowded

- We enable dozens of operating missions: in deep space and Earth orbit
- We will send astronauts beyond low Earth orbit
- We will do ground-breaking direct science using our unique facilities

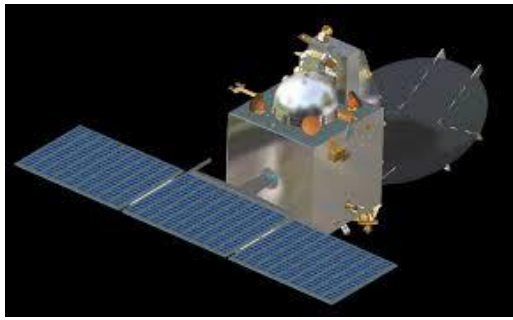


You’re not going anywhere without us!

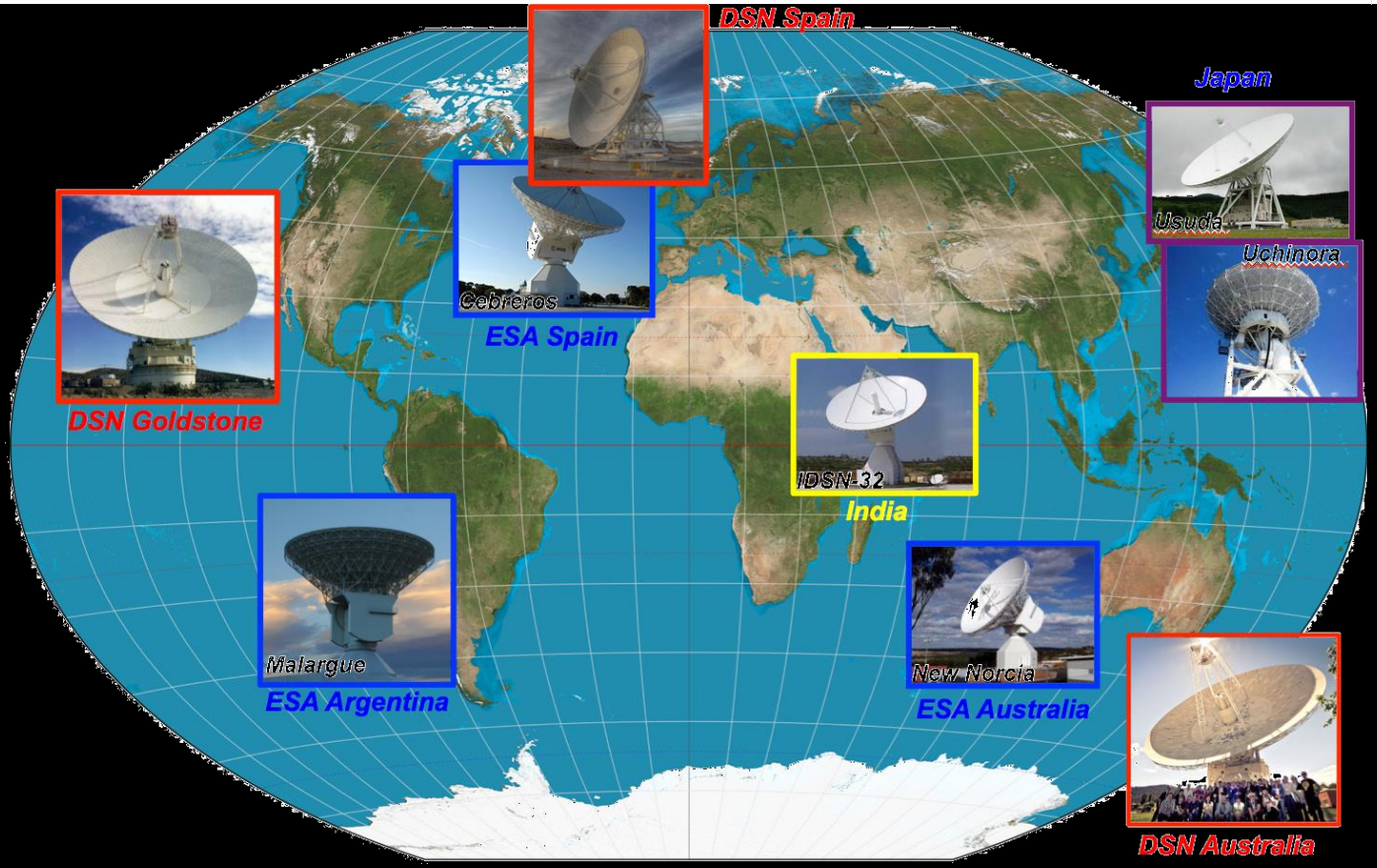
Strategic Partnership Between ISRO and IND

- For nearly a decade, IND has been collaborating with ISRO
  - Tracked the Chandrayaan lunar mission in 2008
  - Currently supporting Mars Orbiter Mission (MOM)
    - About to enter a third extension period

- Planning future support for
  - Chandrayaan-2
  - Aditya solar observer
  - ISRO's next planetary mission



India’s deep space station among leading networks in the world



ISRO is among leading agencies in deep space communications

ISRO can further contribute to the community by participating in international CCSDS (standards) and IOAG (cross-support) meetings

Benefits of Our Strategic Partnership

- **Cost Benefits**
  - Meet redundancy requirements for critical events and navigation by utilizing assets of partner agency
- **Mission Benefits**
  - Quick response to reduce risks
  - Enable or enhance science
- **Collaborative Benefits**
  - Foster international collaboration to benefit science communities
  - Share valuable experience
  - Share in discoveries and excitement